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Construction of suction apparatus for taking samples of dust and gases in the air (1)

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The suction apparatus, used in study of the air of the atmosphere can be divided into two fundamental groups:

1. Suction apparatus working from external sources of whatever energy it uses
2. Suction apparatus working from local sources of energy, found directly adjacent to the apparatus

With the suction apparatus of the first group stationary investigations /I.e. at temporary sites/ are usually conducted on the pollutions of the air of the atmosphere at a fixed point for a considerable time.

The apparatus of the second group enables investigation to be made of pollutions of the air away from these places, usually in field conditions. The work under field conditions is distinguished by a number of special features and presents special demands on the suction apparatus.

In collecting samples for studying the pollutions of the air at points considerably distant from the source of pollution we have small concentrations of dust and to obtain the "perceptible" increase in weight we have to let a large quantity of atmospheric air pass through the apparatus. Considering that the surrounding conditions, for instance the wind, are changing /all the time/, the taking of samples has to be made as rapidly as possible. Also, the change of the direction of the wind necessitates frequent alteration of places for taking samples which can only be done with

apparatus easily moved, yet set up with a minimal loss of time and reliable in operation.

The apparatus used at present to determine the dust content of the air under field conditions (water suction apparatus, portable vacuum pumps, electric suction pumps etc.) did not fully answer our needs, and this made us seek a new solution to the question.

We used an automobile as the source of local energy to collect samples for determining dust content. We were convinced that with proper construction of dust collectors one can conduct the drawing off directly from the carburettor of an internal combustion engine. The following was taken into account at the same time; the automobile suction apparatus had to work continuously and to give enough flow /yield/ at numbers of r.p.m. called "idling"; this attachment to an automobile engine should be applied without any structural changes of the latter; any motor engine with not less than 4 cylinders can be used; the speed of the movement of air in the working part of the extension /allonzh/ should not exceed 1.5 metres a second.

Two types of automobile suction apparatus were developed. The first type of automobile suction apparatus consisted of an elbow shaped tinned pipe with a diaphragm soldered in it, washers to join the manometer, sleeves fixing the suction apparatus to the carburettor, sockets for fixing the metal extensions, a nozzle to enable air to be drawn off according to speeds equal to the speeds of the wind, and the essential number of metal extensions. The suction apparatus is rigidly joined to the carburettor of the engine by a sleeve.

The automobile suction apparatus is shown, ready to work, in Fig. 1.

The automobile suction apparatus of the second type (Fig.2) has a "soft" connection with the carburettor through a rubber hose, and can be used whatever the system of fixing the internal combustion engine to the chassis of the car. This aspirator consists of a T shaped pipe (1) one of the wide ends (2) of which has a washer to fasten metal extensions in it, and a nozzle,and at the other end has a throttle valve [baffle plate] (3). To the narrow nozzle (4) is joined a rubber pipe (5) with an adaptor (6) to join the suction apparatus to the carburettor.

The metal extensions (Fig.3) consist of a duraluminium cyclinder (1) a stiff rigid ring (2) a supporting net (3) and a stiff rigid spring to compress the wool.

During transport the metal extensions are covered by lids. The weight of the extensions without lids varies from 14 to 17 grammes and is practically equal to the weight of glass extensions. The resistance of a metallic extension with a layer of mineral wool 3 grms in weight, at the speed of suction 100 l/m, does not exceed 40 mm of water [column]. At the end of the experiment it rises to 80-100 mm. Trials of metallic extensions showed that using 3 grms of wool not more than 1% dust gets through and this can be disregarded.

The yield of the automobile suction apparatus is determined by the formula $Q = A\sqrt{P}$ where Q = flow in litres/min P = the drop of pressure in the manometer in millimetres of water [column] A - a constant determined in the calibration of the automobile suction apparatus.

The suction apparatus has several nozzles of different diameters. The corresponding nozzle is selected depending on the speed of the wind according to the curves in Fig.4. For convenience of calculation the flow of the suction

apparatus in relation to the manometer drop is given on the same diagram.

The procedure for working the automobile suction apparatus is as follows: the automobile is placed head on to the direction of the wind; the suction apparatus is joined to the carburettor; the power of the wind is measured by an anemometer; the necessary diameter of the nozzle is determined by the curve; the necessary drop in pressure on the throttle valve /baffle plate/ of the carburettor or of the suction apparatus is obtained by the manometer; the extension is put in with the correct nozzle and the taking of samples proceeds; on finishing the taking of samples the metal extension is taken out, closed with two lids and kept in this way until it is weighed.

On checking in practical work, the quality of automobile suction apparatus, of the constructions described, was found to be adequate, allowing us to recommend it for wide use in studying the dust of atmospheric air under field conditions.

The apparatus used at present for determining the gases in the atmosphere, in particular SO_2, does not fully fulfil our requirements under field conditions, we therefore constructed a special "field aspirator" of the accumulator type, shown in Fig. 5.

All necessary apparatus and supply of current to the field aspirator are mounted in one box with a base of 250 x 200 mm., and a height of 300 mm. The box has doors on its front and back wall. At the rear compartment are placed:

A perfected centrifugal air blower, directly joined to the axis of a D.C. motor and accumulators.

At the front are placed:

A Schott absorber with a plate with fine pores.

A rheometer, an electric flow regulator, and 8 test tubes for the necessary reagents.

The weight of the whole apparatus is 8 kgm. The flow of the suction apparatus with a schott absorber reaches a maximum 7 l/min. With full charge of the accumulators the working period is 5 hours. Working under field conditions a spare accumulator is required.

A field suction apparatus of this construction was tested for a year on practical work, and it was found to be very convenient apparatus for studying atmosphere.

Figure Captions

Fig. 1 p.49

Fig. 2 p.50. Automobile suction apparatus of the 2nd type

1. T shaped pipe 2. washer to fasten metal extensions
3. Throttle valve-Baffle Plate 4. The narrow nozzle
5. The rubber sleeve 6. the adaptor

Fig. 3 Metal extension

1. Duraluminium cylinder 2. stiff rigid ring
3. Supporting grid 4. Tightening ring spring
5. Mineral wool

Fig. 4. Graph of working speeds in the extension, speeds of withdrawal with nozzle and productivity of the automobile suction apparatus.

Fig. 5. Field aspirator with open front doors.

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